Effect of pre-sowing treatments on germination and initial seedling development of *Albizia saman* in the nursery

Mohammed Alamgir and M. K. Hossain

Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong-4331, Bangladesh

Abstract: *Albizia saman* (Jacq.) F. Muell. commonly known as rain tree seeds were treated with five pre-sowing treatments to study the effect of pre-sowing treatments on germination and initial seedling development in the nursery. The experiment was established in the nursery of the Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong, Bangladesh. Results revealed that Nail clipping in one side of the seed (at the distal end of the seed) (T_4) provides the highest (50%) seed germination. The second highest germination (42%) was obtained for the seeds treated with immersion in cold water for 24 h (T_1). Germination was completely inhibited when the seeds immersed in boiled water for 30 s followed in cold water soaking for 24 h. Other germination parameter and initial morphological growth and biomass production of the seedlings was also higher for the treatments T_4 and T_1 in comparison to the control (T_0) treatment. Pre-sowing treatments of T_4 e.g. Nail clipping in one side of the seed (at the distal end of the seed) and T_1 (Seeds immersed in cold water for 24 h) may be recommended for maximum germination and initial vigorous seedlings growth of *Albizia saman* in the nursery.

Keywords: Pre-sowing treatments; Germination; Seedling growth; *Albizia sama;* Seedling biomass

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Introduction

Albizia saman (Jacq.) F. Muell. (Leguminosae, Subfamily Mimosoideae) commonly known as rain tree is a fast growing tree which obtains a large size. The species is native from Southern Mexico and Guatemala south to Peru, Bolivia and Brazil (Little and Wadsworth 1989). It is naturalized throughout the tropics and has been introduced in sub-tropical areas. *A. saman* can obtain a height of 30–45 m and diameter at breast height (DBH) of 150–250 cm. The brown gray bark is rough and furrowed into ridges and plates (Little and Wadsworth 1989). A good site can produce 10–25 m^3h^{-1} a^{-1} under a 10-15 year rotation (F/FRED 1994). It is most common as a pasture, shade or ornamental tree, but has numerous other uses. *A. saman* is planted along roads throughout the tropics. In parks and commons, its high arching branches provide welcome protection from the heat of the tropical sun. Trees serve as windbreaks and are cultivated for their beautiful pink flowers. The wood is highly valued for the manufacture of furniture, cabinets, decorative veneers, bowls and other handicrafts. The light-weight wood (specific gravity 0.48) is strong, durable, works easily and takes a good finish (Chudnoff 1984). The shade and nitrogen-rich leaf-litter of *A. saman* improve the nutritional value of understory grass (Allen and Allen 1981). *A. saman* is appropriate in home gardens where it provides a service role and multiple products simultaneously (Subansenee 1994). In Bangladesh the species is widely used in homegardens, roadside plantation, agroforestry purposes and both in public and private plantation programs.

The dark-brown to black pods are hard and thick with a raised seam. The pods are 8-20 cm long and about 2 cm wide. The pods do not readily open and remain on trees for long periods. Seeds are red-brown oblong and squarish. There are 5000 - 8000 seeds kg^{-1}. Seeds of *A. saman* have hard, impermeable seed coats. Two methods of seed scarification are recommended, e.g. for small quantities of seed, cut through the seed coat opposite the micropyle, or pointed-end of the seed, taking care not to damage the seed embryo. For large quantities of seed, pour boiled water over the seeds, soak and stir for two minutes. Drain off the hot water. With either method of scarification, the seed should be soaked in cool water overnight before sowing (NFTA 1989). The effects of pretreatment on the germination of some species are reported by Ahmed *et al.* (1983), Nagaraja and Christopher (1991), Koirala *et al.* (2000) and Khan *et al.* (2001). However, there is little information on the effect of *A. saman* seed treatment and its subsequent effects on seedling development in the nursery. Poor germination and delayed nursery establishment limits the wide cultivation of the species in both forestry and homestead plantation programs. A good planning and profitability of forest nurseries depends on the appropriate techniques that speed up germination and obtain a more reliable germination of seeds sown (Koirala *et al.* 2000). Thus, the objectives of the present study were to determine the optimum pretreatment methods that maximize total germination, germination rate and also to study the effects of different treatments on initial seedling development in the nursery.

Materials and methods

Study site, growing media and seeds used in the experiment

The experiment was established in the nursery of the Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong, Bangladesh. The seeds were sown and grown in the soils collected from the forest areas of the Campus. The soil was sieved well (<3mm) and mixed with decomposed cowdung in a ratio of 3:1 and filled in the polybag of size10 cm

Biography: Corresponding Author: Mohammed Kamal Hossain (1957-), male, Professor in the Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong-4331, Bangladesh.
E-mail: hossainmk2001@yahoo.com
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× 15 cm. The volume of the polybag was 500 cm^3 (Banik, 1992). All treated seeds of *A. saman* were sown in the filled polybag (two seeds per polybag) and arranged in the nursery bed. Seeds of uniform size were selected from the lot to reduced non-treatment variation as seedling vigor was found positively correlated with seed size (Bonner 1987).

Experimental design and treatment combinations

A randomized complete block design with three replicates was adopted for the experiment. Twenty polybags for each replication of each treatment were used. Therefore, a total of three hundred uniform seeds were subjected to five different pre-sowing treatments. Five pre-sowing treatments used in the experiment are as follows:

T_0: Control (seeds provided no treatment);

T_1: Seeds immersed in cold water for 24 h;

T_2: Seeds immersed in boiled water for 30 s, followed in cold water soaking for 24 h;

T_3: Seeds immersed in boiled water for 1min, followed in cold water soaking for 24 h;

T_4: Nail clipping in one side of the seed (at the distal end of the seed).

Assessment of *A. saman* seedlings

The effects of pre-sowing treatments were assessed periodically through germination and initial growth performance of the seedlings in the nursery. The germination was recorded everyday from the date of sowing and continued till being the last germination (45 days after seed sown). The seedlings were allowed to grow in the nursery bed for altogether 90 days. Five seedlings from each replicate were randomly selected and uprooted very carefully to estimate the seedling oven-dry biomass. The seedlings were then separated into its root and shoot components. Shoot and root was oven dried at 70°C for 48 h and oven dry weight was determined. Data were statistically analyzed for studying the morphological growth variations for each pre-sowing treatments. The following parameters were assessed to evaluate the pre-sowing treatments:

Daily and cumulative germination counts

Germination counts were recorded daily till the last germination occurred. The criterion for seed germination was visible protrusion on the surface of the soil at least 0.5 cm of the cotyledon and hypocotyle of the seedlings. Daily germination percentages were summed up to obtain cumulative germination percents for each treatment.

Germination phases

The imbibition period (the number of days from sowing to commencement of germination) and the total germination period (the number of days from sowing to completion of germination) were recorded for each pre-sowing treatment.

Germination energy and germination value

The germination energy, e.g. the germination percentages when the mean daily germination (cumulative germination percentage divided by the time elapsed since sowing date) reached its peak, was also determined. Germination energy is also measured of the speed of germination and hence, it is assumed as a measure of the vigor of the seed and of the seedling it produces. The interest in germination energy is based on the theory that only those seeds which germinate rapidly and vigorously under favorable conditions in the laboratory are capable of producing vigorous seedlings under field condition while weak and delayed germination is fatal (Aldhous 1972). The germination value (GV), a composite value that combines both germination speed and total germination which provides an objective means of evaluating the results of germination values calculated using the formula of Djavanshir and Pourbeik (1976):

$$GV = (\sum DGs / N) GP / 10$$

where, *GV* is Germination value, *GP* is Germination percentage at the end of the test, *DGs* is daily germination speed obtained by dividing the cumulative germination percentage by the number of days since sowing, $\sum DGs$ is The total germination obtained by adding every DGs value obtained from the daily counts, *N* is The total number of daily counts, starting from the date of first germination, 10 = Constant

Seedling vigor

To assess the seedling vigor of the experiment, total height (from the soil surface to seedling tip) of each seedling in each sub-plot was measured using a ruler to the nearest 0.1 cm. Vigor Index was calculated according to Abdulbaki & Anderson (1973) as germination percent X seedling total length i.e. total shoot and root length.

Quality Index (QI)

It was developed by Dickson *et al.* (1960) to quantify seedling morphological quality was calculated as follows:

$$QI = T_{dw} / (\frac{H}{D_c} + \frac{S_{dw}}{R_{dw}})$$

Where, *QI* is quality index, T_{dw} is total dry weight (g), *H* is seedling height (cm), D_c is collar diameter, S_{dw} is shoot dry weight (g), R_{dw} is root dry weight (g).

Results and discussion

Germination percentage, Germination value and Germination energy

The highest germination percent (50 ± 1.15) was observed in T_4 followed by T_1 (42 ± 1.15) and significantly different from other treatments (Table 1). Considering the germination percentage pre-sowing treatments are significantly different ($P<0.05$) from each other. Pre-sowing treatments had significantly different effects on seed imbibition and germination periods also. The imbibition period of T_4 was significantly ($P<0.05$) shortest whereas highest imbibition period was found in T_3 treatment. In Control (T_0) and T_1 seeds imbibition period is not significantly different from each other. However, germination period was significantly ($P<0.05$) shorter in T_4 and T_1 and significantly higher in T_0 and T_3 treatments. Germination value was highest (24) in T_4 treatment followed by T_1 and T_0 treatments (Table 1). Pre-sowing treatment was carried out in order to enhance rapid and uniform germination of seed sown in the nursery (Schmidt 2000). Manual pretreatment of individual seeds, e.g. by abrasion, or nicking is quite efficient in overcoming dormancy and minor damage to the cotyledons is unlikely to affect germination (Cremer 1990). Similarly hot water overcomes physical dormancy in

the legume species (Brant *et al.* 1971; Dell 1980), but in the experiment heat damage was observed for T_2 treatments as there was no seed germination (Table 1). This agreed with the findings of Todd-Bockarie *et al.* (1993), Babeley and Kandya (1988), Teketay (1996) and Sajeevukumar *et al.* (1995) that boiling water was lethal to some extent.

Table 1. Effect of different pre-sowing treatments on germination, imbibition, germination period and germination energy of *Albizia saman* seeds with Standard Error (ER).

Treatments	Germination (%)	Imbibition (days)	Germination period (days)	Germination value	Germination Energy (%)
T_0	35c *± 1.15	4ab ± 0.58	21a ± 0.58	14.95	30
T_1	42b ±1.15	4ab ± 0.58	15b ± 0.58	17.80	20
T_2	0e	0c	0c	0	0
T_3	20d ±1.15	6a ± 1.15	19a ± 0.58	7.05	13
T_4	50a ± 1.15	3b ± 0.58	14b ± 1.15	24.13	37
F	121.688	2.714	18.714	-------	------
P	0.00	0.115	0.001	-------	-------

Note: * Means followed by the same letter(s) in the same column are not significantly different at P<0.05, Duncan's Multiple Range Test (DMRT).

Mean daily and cumulative germination percent

The mean daily germination percent was highest at the 4th day after sowing in T_4 treatments and slowed down sharply from the day through the 45th day after sowing (Fig. 1). Cumulative germination percent rises from 3rd day up to 14th day and remained constant up to the 45th day (Figure 2). In T_1 and T_0 treatments, seeds attained highest mean daily germination percent at 5th and 8th day after sowing respectively (Fig. 1). The cumulative germination percent of T_4 treatment was always highest in comparison to other treatments (Fig. 2). In T_1 treatment seeds attained the highest cumulative germination percent at the 13th day after sowing. In general pre-sowing treatment showed both higher mean daily and cumulative germination percent in comparison to control (T_0) seeds except T_3 treatment.

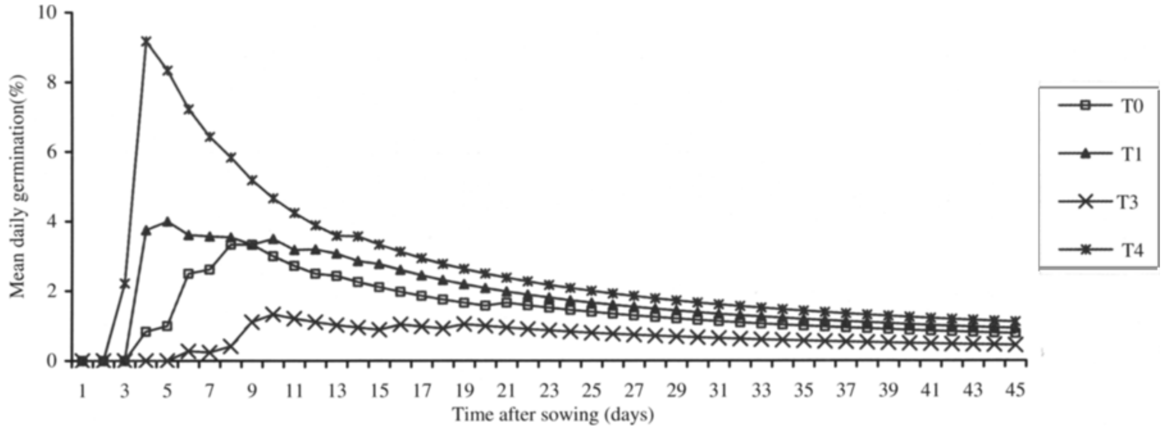

Fig. 1 Effect of pre-sowing treatments on mean daily germination percent of *Albizia saman* seeds.

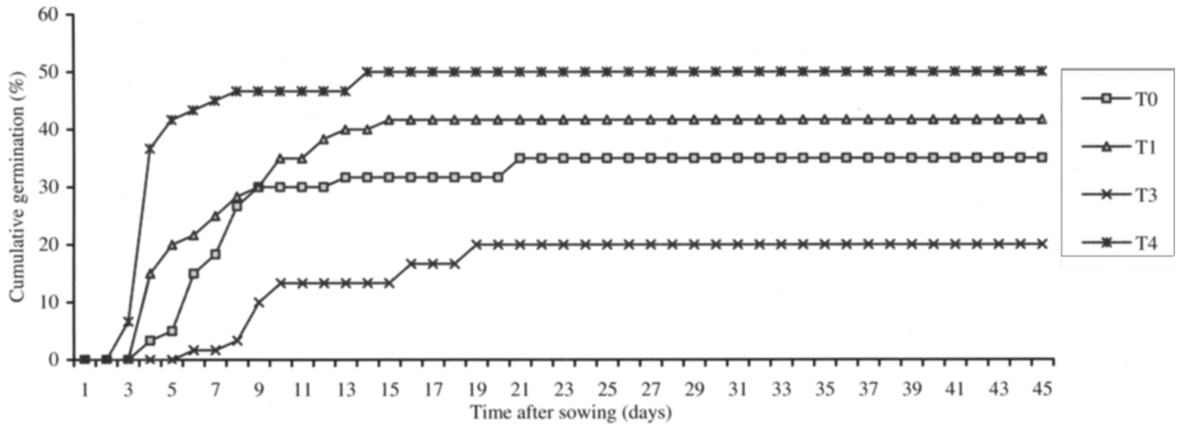

Fig. 2 Effect of pre-sowing treatments on cumulative germination percent of *Albizia saman* seeds.

Seedling vigor, morphological growth and dry matter production

Seedling growth parameters like height, root length, total length, collar diameter, leaf number, nodule number and vigor index were assessed with the pre-sowing treatments grown in the nursery. The mean height of the seedling was found highest (39.44 ± 0.95 cm) in T_0 treatment followed by T_1 and T_4 treatments. Since there is no germination in T_2 treatment the lowest height was found in T_3 treatment and significantly different from each other (P<0.05). Considering the collar diameter of the seedlings, T_1 have the maximum collar diameter growth (0.77±0.2 cm), followed by T_4 (0.65±0.023 cm) and T_0 (0.62±0.66 cm), and it was significantly different (P<0.05) from other treatments. Whereas, highest root length was found in T_3 (32.8±0.63 cm) followed by T_1 (30±0.58 cm) and T_0 (25.8±0.78 cm) respectively. The number of leaves was significantly (P< 0.05) highest (22±2.73) in T_1 and lowest (15 ± 0.88 each) in T_3 and T_4 treatments. Similarly, the number of nodules is significantly (P<0.05) highest in T_1 (72±2.73) treatments followed by T_4 (62±1.45) and T_0 (57±3.78) (Table 2). Considering the seedling vigor index, T_4 treatment possessed highest value (2884±107.99) followed by T_1 (2805±109.17), T_0 (2285± 131.57) and T_3 (1308 ± 94.36). Treatment T_4 and T_1 are not significantly different from each other but has significantly (P<0.05) higher vigor index than other treatments (Table 3).

Table 2. Effect of pre-sowing treatments on seedling height, root length, total length, collar diameter, mean leaf number and mean nodules number with Standard Error(ER).

Treatments	Height (cm)	Root length (cm)	Total length (cm)	Collar diameter (cm)	Leaf number	Nodules Number
T_0	39.44a*± 0.95	25.78b ± 0.78	65.22a ±1.72	0.62ab ± 0.66	17b ±1.20	57b ±3.78
T_1	36.66a ±1.39	30a ± 0.58	66.77a ±1.06	0.77a ± 0.02	22a ±1.20	72a ± 2.73
T_2	0c	0d	0c	0c	0c	0d
T_3	32.49b ±1.70	32.83a ± 0.63	65.32a ±1.08	0.58b ± 0.05	15b ± 0.88	40c ± 7.26
T_4	35.47ab ± 0.56	22.22c ±1.47	57.70b ±1.82	0.65ab ± 0.023	15b ± 0.88	62ab ± 1.45
F	5.508	24.904	7.831	3.23	8.958	9.25
P	0.024	0.00	0.009	0.082	0.006	0.006

Note: * Means followed by the same letter(s) in the same column are not significantly different at P<0.05, Duncan's Multiple Range Test (DMRT).

Table 3. Effect of pre-sowing treatments on shoot dry weight, root dry weight, total dry weight, Vigor Index and Quality Index with Standard Error (ER)

Treatments	Shoot dry weight (g)	Root dry weight (g)	Total dry weight (g)	Vigor Index	Quality Index
T_0	4.73a * ± 0.40	1.59a ± 0.3	6.32a ± 0.42	2285.90b ±131.57	1.74a ± 0.05
T_1	5.26a ± 0.34	1.63a ± 0.25	6.89a ± 0.27	2805.81a ±109.17	1.87a ± 0.32
T_2	0b	0b	0b	0d	0b
T_3	4.36a ± 0.33	1.34a ± 0.14	5.70a ± 0.45	1308.31c ± 94.36	1.50a ± 0.16
T_4	4.88a ± 0.20	1.39a ± 0.12	6.27a ± 0.32	2884.54a ±107.99	1.54a ± 0.14
F	1.308	0.88	1.694	42.292	0.791
P	0.337	0.491	0.245	0.00	0.532

Note: * Means followed by the same letter(s) in the same column are not significantly different at P<0.05, Duncan's Multiple Range Test (DMRT).

The oven dry weight of the seedling components (root and shoot) of different treatments were statistically analyzed (Table 3). Though there were variations in seedling shoot, root and total dry weight, not significantly differences were observed among the treatments. Mean shoot, root and total biomass was highest (5.26± 0.34 g, 1.63±0.25 g, 6.89±0.27g) in T_1 treatment followed by T_4 (4.88±0.20 g, 1.39± 0.12 g, 6.27±0.32g) and T_0 (4.73±0.40g, 1.59±0.3 g, 6.32±0.42g) treatments respectively. In all treatments quality index was not varied significantly though there was a variation among the treatments. T_1 seedlings attained the highest (1.87±0.32) quality index followed by T_0 (1.74±0.05) and T_4 (1.54±0.14) treatments. T_3 treatment attained lowest quality index (1.50±0.16). Legume seeds have hard seed coat which plays a significant role in the process of germination and seedling vigor mainly by restricting the water absorption to the embryo (Dell 1980; Teketay 1996; Koirala *et al.* 2000) Legume seeds with hard seed coats have been reported to enhance the germination with pre-sowing treatments (Doran *et al.* 1983; Kariuki 1987; Palani *et al.* 1996). *A. saman* has a hard and impermeable seed coat which prevents imbibition and sometimes also gaseous exchange. The present finding is also agreed with the findings of Zodape (1991), Randhawa *et al.* (1986), Mishra and Singh (1981) that pre-sowing treatment increased the legume seed germination. In the present study, seeds treated with nail clipping in one side of the seed (T_4) provided significant higher germination, germination value, germination energy, nodules number and vigor index. T_4 treatment also showed the significant lower imbibition days and germination period than control (T_0) treatments. Therefore, seeds treated with nail clipping in one side of the seed (T_4) may be recommended for maximum seed germination and vigor seedling production. As it is time and labor consuming seeds treated with 24 h soaking in cold water (T_1) are also recommended for large scale seed germination and seedling growth of *Albizia saman*.

References

Abdul – Baki, A. and Anderson, J.D. 1973. Vigor determination in Soyabean seed by multiple criteria [J]. Crop Science, **13**: 630–633.

Ahmed, F.U., Das, S. and Hossain, M.A. 1983. Effect of seed treatment on the germination of rakta kambal seeds [J]. Bano Biggyan Patrika, **12** (1&2): 62–65

Aldhous, J.R. 1972. Nursery practices [R]. Forestry Commission Bulletin No. 43. London: Page Bros Ltd., 184 pp.

Allen, O.N. and Allen, E.K. 1981. The Leguminosae: a source book of characteristics, uses and nodulation [M]. Madison, Wisconsin, USA:.Wisconsin Press, 590–592 pp.

Babeley, G.S. and Kandya, A.K. 1988. On finding out some suitable pretreatment for Cassia fistula Linn. Seeds [J]. Journal of Tropical Forestry, **4**: 147–154.

Banik, H. 1992. Technology of raising timber, flower and fruit tree seedlings in the nursery [M]. Chandpur press and publications. 38, Banglabazar, Dhaka. Bangladesh. 30pp.[In Bangla]

Bonner, F.T. 1987. Important of seed size in germination and seedling growth [C]. In : Kamra S. K. and Ayling R. D. (eds.). Proceedings of the International Symposium on Forest Seed Problems in Africa held at Harare, Zimbabwe, 23 August-2 September 1987. 53–61 pp.

Brant, R.E., Mckee, G.W. and Cleveland, R.W. 1971. Effect of chemical treatment on hard seed on *Pengrift crownvetch* [J]. Crop Science, **11** (1): 1–6.

Chudnoff, M. 1984. Tropical timbers of the world [M]. Agriculture Handbook 607. USDA Forest Service. Washington, DC. 134 pp.

Cremer, K.W. 1990. Trees of Rural Australia: Chapter 5: Nursery practice [M]. Melbourne –Sydney: Inkata Press.

Dell, B. 1980. Structure and function of the Strophiolar plug in seeds of *Albizia lophantha* [J]. American Journal of Botany, **67**(4): 556–561.

Dickson, A., Leaf, A.L. and Hosner, J.F. 1960. Quality appraisal of white spruce and white pine seedling stock in nurseries [J]. For. Chronicle, **36**: 10–13.

Djavanshir, K. and Pourbeik, H. 1976. Germination value: A new formula [J]. Silvae Genetica, **25**: 79–83.

Doran, J.C., Trunbull, J.W., Boland, D.J. and Gunn, B.V. 1983. Handbook on Seeds of Dry Zone Acacias [M]. FAO, Rome. 59–63pp.

F/FRED. 1994. Growing multipurpose trees on small farms (2nd ed.) [M]. Module 9. Species Fact Sheets. Bangkok, Thailand. Winrock International, 22–23pp.

Kariuki, E.M. 1987. Effects of pre-sowing treatments on seed germination of four important tree species in Kenya [C]. In: Kamra S. K. and Ayling R. D. (eds.). Proceedings of the International Symposium on Forest Seed Problems in Africa held at Harare, Zimbabwe, 23 August-2 September 1987. 143–153pp.

Khan, B.M., Koirala, B. and Hossain, M.K. 2001. Effect of different presowing treatments on germination and seedling growth attributes in Ghora Neem (*Melia azedarach* L.) [J]. Malaysian Forester, **64**(1): 14–21.

Koirala, B., Hossain, M.K. and Hossain, M.S. 2000. Effect of presowing treatments on *Adenanthera pavonina* L. seeds and initial seedling development in the nursery [J]. Malaysian. Forester, **63**(2): 82–91.

Little, E.L. and Wadsworth. F.H. 1989. Common trees of Puerto Rico and the Virgin Islands [M]. Agriculture Handbook No. 249. USDA Forest Service. Washington, DC. 164–66pp.

Mishra, C.M. and Singh, S.L. 1981. Seed germination studies on three predominant tree species of Southern Uttar Pradesh [J]. Ann. Arid Zone, **20**(3): 193–198.

Nagaranja, B. and Christopher, P.J. 1991. Germination studies in *Adenanthera pavonina* [J]. Malaysian Forester, **27**(4): 265–366.

NFTA, 1989. A quick guide to useful nitrogen fixing trees from around the world [R]. Winkock International, Arkansas, USA.

Palani, M., Dasthagir, M.G., Kumaran, K. and Jerlin, R. 1996. Effect of presowing treatment on growth attributes of *Albizia lebbeck* (L.) Benth [J]. Annals of Forestry, **4**(1): 85–88.

Randhawa, H.S., Sharma, H.L., Kaur, J. and Rattan, G.S. 1986: The acceleration of germination of *Cassia fistula*: Fungi associated with rotting seeds and abnormal seedlings [J]. Indian Forester, **112**(6): 524–527.

Sajeevukumar, B., Sudhakara, K., Ashokan, P.K. and Gopikumar, K. 1995. Seed dormancy and germination in *Albizia falcataria* and *Albizia procera* [J]. Journal of Tropical Forest Science, **7**(3): 371–382.

Schmidt, L. 2000. Guide to handling of tropical and sub-tropical forest seed [M]. Danida Forest Seed Center. 511p.

Subansenee, W. 1994. Economic value of *Albizia saman* [C]. In: Raintree J.B. and Francisco H. A. (eds.), Marketing of Multipurpose Tree Products in Asia. Bangkok, Thailand. Winrock International, 229–35 pp.

Teketay, D. 1996. Germination ecology of twelve indigenous and eight exotic multipurpose leguminous species from Ethiopia [J]. Forest Ecology and Management, **80**: 209–223.

Todd-Bockarie, A.H., Duryea, M.L., West, S.H. and White, T.L. 1993. Pretreatment to overcome seed coat dormancy in *Cassia sieberiana* [J]. Seed Science & Technology, **21**: 383–398.

Zodape, S.T. 1991. The improvement of germination of some forest species by acid scarification [J]. Indian Forester, **117**(1): 61–66.